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IMPLEMENTING STATE SOLAR FINANCIAL INCENTIVES AND RD&D PROGRAMS

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CHANGING FEDERAL-STATE RELATIONSHIPS IN ENERGY

As energy supply and demand increasingly are recognized as public problems, one can expect greater involvement in energy by governments at all levels. While federal legislation such as Public Utility Regulation and Policy Act (PURPA) introduced the federal presence in areas formerly the province of states, some state public utility commissions are taking new, aggressive stances on regulation, plant siting, and even fuel choice. As energy supply and use become recognized as national problems, state programs will flourish only if they complement large federal programs of research, development, demonstration, financial subsidies, information, training, etc. National problems need not require national solutions, however, and the natural decentralization of solar technologies now on the market and their localized character (i.e., cost effectiveness is a function of local climate) suggests the need for effective, well-defined state programs tailored to local conditions.

Solar technologies are dispersed technologies. Their performance and costs depend heavily on climate, insolation, and type of applications (e.g., residential hot water heating, industrial process heat, remote electricity generation, and water pumping). Accordingly, the type, extent, and timing of government stimulation of solar applications should vary regionally to make most efficient the expenditure of public funds. The authors of a comprehensive analysis of policy options for commercializing solar heating and cooling systems stated the point emphatically:

> The optimal mix of incentives to apply in any particular region must be strongly dependent upon regional characteristics. It must be recognized that some barriers are best overcome by national strategies, some by state strategies, and some by local tailoring of the various incentive programs (Bezdek et al. 1978, p. 460).

Given the extensive history of state solar incentives relative to federal actions intended to achieve similar objectives and the inherently different consequences that the same incentives will have in different regions of the country, it is important that federal programs encourage and complement, rather than overwhelm and conflict with, state solar incentives.

States with abundant supplies of solar radiation such as California and New Mexico have taken early, significant steps to stimulate the purchase of solar systems by homeowners and businesses. Other states have focused more on the development and demonstration of solar systems, while still others have passed legislation that symbolizes positive attitudes toward solar and renewable energy, rather than directly promoting the development and use of systems. The efficacy and problems of each approach should be the subject of systematic study so that both state and federal officials can benefit. State solar RD&D programs can complement significantly federal research programs in the overall national effort to develop and apply renewable energy sources. Since solar and renewable energy technology performance is rooted in localized climatic and natural resource conditions, states can significantly assist in developing, adapting, and demonstrating renewable energy technologies designed specifically for local conditions.

Increased application of solar and renewable technologies as a public policy goal began with the states, which are, therefore, a valuable source of information about why various technology development and application programs have worked. State experience should illuminate future energy policy choices by both state and federal officials. The research reported here endeavors to assess that experience.

STATE AND FEDERAL POLICY CONCERNS IN SOLAR AND RENEWABLE ENERGY

Fundamental to solar and renewable energy policy are questions about the cost and efficacy of incentive programs designed to stimulate the application of solar and renewable energy technologies. Program costs include both costs to the treasury and the administration; effectiveness usually is measured by various indicators of the consequences of the program, which will be different for programs with different objectives. Policy officials interested in whether solar financial incentives work will want to know:

- How much sales of solar equipment increased;
- How much money was saved through reduced energy costs;
- How much the consumption of fossil fuels was reduced;
- How many new jobs were created; and
- How many new solar firms were created.

Policy officials interested in the impact of RD&D programs will ask:

- How well solar systems under test worked;
- Whether solar demonstration projects increased solar sales;
- The extent to which development projects increased the performance of systems;
- Whether the results of RD&D projects were disseminated;
- The proportion of RD&D projects that were successfully commercialized; and
- The quality of research performers supported.

Most, if not all, of these evaluative questions cannot be answered from information now available from either federal or state solar programs. Yet new solar incentive programs are being introduced continually into the Congress and state legislatures, and public officials still ask how existing programs can be improved.

In addition to the previous questions are related issues about the design and administration of solar incentive programs:

- Which government agency should be responsible for developing rules and regulations governing eligibility for financial incentives or applications for RD&D awards? Where should it be located within the government structure?
- Should the agency that develops rules and regulations also administer the program?
- What funding arrangements should be employed to support the incentive: annual appropriations, sale of bonds, severence taxes, or other means?
- What kinds of staff should develop rules and regulations or administer the program: scientists and engineers, manager/administrators, or persons with backgrounds in economics and business?
- How specific should rules and regulations be?
- How much documentation should be required of persons submitting claims for a financial incentive?

- What is the appropriate role of nongovernment groups such as industry and trade associations, professional groups, solar activists, and universities?
- How much emphasis should be placed on solar demonstrations as opposed to research or development projects?

The research reported here specifically addresses these latter questions and develops preliminary information on the costs and efficacy of solar financial incentives and RD&D programs. The data were drawn from 23 state solar incentive programs, divided nearly equally between financial incentives (11 states) and RD&D programs (12 states) (see Tables 1 and 2).

FRAMEWORK

The framework of the research assumed that the steps taken to execute a policy are as significant for achievement of policy objectives as the design of policy itself. The primary research questions addressed what Hargrove (1975) has called the "missing link" between policy and outcomes: an implemented program.* The project focused on measures of implementation success and on the relationships between these measures and a variety of implementation conditions that describe the execution of particular state solar energy initiatives through administrative action. It sought for each type of policy initiative the reasons for the extent of program implementation observed. We expected that factors other than the type of initiative or mode of implementation, especially the local political climate, existing state statutes, state energy costs and availability, and state size and growth would be important. These were explicitly incorporated in the analysis.

Measures of implementation success used in the research indicated scale or level of effort (e.g., cost of the program to the treasury and number of staff), administrative costs, and implementation outcomes. For state solar financial incentive programs, implementation outcomes were measured by:

- Time required for the implementing agency to develop and formally introduce rules and regulations governing eligibility for the incentive;
- Ratio of number of solar income tax credit claims processed to number of solar systems installed during 1977; and
- Ratio of number of valid claims processed to total number of tax returns filed in 1977.

For state solar RD&D programs, implementation outcomes were measured by:

- The extent of user involvement in the RD&D project selection process;

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*Implementation refers to the process by which broad policy mandates (often embodied in legislation) are interpreted, refined, and executed by administrative agencies. Implementation activities thus include the development of regulations, standards, and codes; the formulation of eligibility criteria; the development of administrative procedures and practices; and the establishment of organizational responsibilities and institutional arrangements.

Table 1. STATE FINANCIAL INCENTIVE PROGRAMS STUDIED

State	Year	Incentive Type	Implementing Agency
Arizona	1977	Income Tax Credit	State Department of Revenue
	1974	Property Tax Exemption	
	1977	Use Tax Exemption	
	1975	Accelerated Amortization	
California	1976	Income Tax Credit	Franchise Tax Board; California Energy Commission Department of Housing and Community Development
	1978	Loan Terms	
Hawaii	1976	Income Tax Credit	State Tax Department
	1976	Property Tax Exemption	
Kansas	1976	Income Tax Credit	State Department of Revenue
	1977	Taxable Income Deduction (Business)	
	1977	Property Tax Reimbursement	
	1977	Accelerated Amortization (Business)	
Massachusetts	1975	Property Tax Exemption	Local Assessor
	1977	Sales Tax Exemption	State Department of Corporation and Taxation
	1976	Deduction-Business	
	1977	Loan Terms	Local Bank/Credit Union
Michigan	1976	Property Tax Exemptions	Local Government Services
	1976	Use Tax Exemption	State Department of Treasury
	1976	Business Activities Exemption	State Tax Commission
Montana	1977	Income Tax Credit	State Department of Revenue
	1977	Tax Deduction—Capital Investment	Income Tax Section
	1975	Loan Terms	Public Service Commission
New Mexico	1975	Income Tax Credit	State Department of Taxation and Revenue
	1977	Tax Credit-Irrigation	
North Carolina	1975	Income Tax Credit	State Department of Revenue
	1975	Property Tax Mod. Exemption	Local Assessor
North Dakota	1977	Income Tax Credit	State Tax Commission
	1975	Property Tax Exemption	Local Assessors
Oregon	1977	Income Tax Credit	State Department of Revenue
	1975	Property Tax Exemption	Local Assessor
	1977	Loan Terms	State Department of Veterans Affairs

Table 2. RD&D PROGRAMS STUDIED

State	Year of Enactment	Source of Funds	Implementing Agency
Arizona	1977	GR[a]	Arizona Solar Energy Research Commission
Colorado	1974	GR	Colorado Energy Research Institute
California	1974	EUT[b]	California Energy Resources, Conservation & Development Commission
Florida	1974	GR	Florida Solar Energy Center
Hawaii	1974	CR/B[c]	Department of Planning and Economic Development
Maine	1975	GR	Maine Office of Energy Resources
Montana	1975	ST[d]	Department of Natural Resources and Conservation
New Mexico	1975	ST	Energy and Minerals Department
New York	1975	EUT	New York State Energy Research & Development Authority
North Carolina	1975	GR	North Carolina Energy Division, Department of Commerce
Ohio	1975	GR	Ohio Energy and Resource Development Agency
Texas	1977	GR	Texas Energy Advisory Council

[a]GR is general revenue.
[b]EUT means energy use tax.
[c]B is bonds.
[d]ST stands for severance tax

Source: Franklin Institute, 1978, National Conference of State Legislatures, 1978.

- Whether market analyses were performed as part of the selection process for projects intended for commercialization;
- Time required for the implementing agency to develop and formally introduce rules and regulations governing eligibility for RD&D funds, application procedures, and project selection processes and criteria;
- Proportion of cost sharing with RD&D performer;
- Proportion of cost sharing with the federal government; and
- Percentage increase in dollar value of grants and contracts from 1977 to 1978.

Administrative and organizational factors expected to influence implementation success were identified from the literature on implementation, from the earlier pilot study of state solar incentive programs (Ashworth 1979), and from discussions with state solar energy officials. Table 3 lists factors that are common to both RD&D and financial incentive programs.

DESCRIPTION OF STATE SOLAR FINANCIAL INCENTIVE PROGRAMS

In late 1978, five kinds of solar financial incentive programs were being implemented in the eleven study states at the time this project was initiated: income tax credits, property tax exemptions, sales and use taxes, loans, and business tax credits. The 11 states, the types of financial incentives enacted in each as of late 1978, and the primary implementing agencies are listed in Table 1.

The most frequent type of solar financial incentive was income tax credit programs for individuals. Nine of the eleven states had such incentives; other types of financial incentives were scattered among these and the remaining states. Because income tax credits dominated the solar-related financial activities of the states studied, most of the data included in the analysis were derived from agencies implementing this type of program. In two states the principal solar financial incentive to be implemented was a loan program; therefore, in these states the agencies responsible for the loan program provided data on implementation.

In the 11 study states, a total of 15 state agencies were responsible for implementing solar or alternative energy financial incentive programs. Of the 9 study states with some form of income tax credit, 2 states had programs for which implementation responsibility was shared jointly by 2 agencies; in California and Arizona, the energy agency and tax authority formally shared responsibility for implementing the income tax credit incentive. In Oregon, two solar financial incentive programs were studied, each of which had its own implementing agency. The Oregon income tax credit program was implemented by the Department of Energy, and the veterans' loan program for solar applications was implemented by the Department of Veterans' Affairs. The Massachusetts Energy Office was technically involved in implementing each of that state's financial incentive programs, but the business tax credit was largely the responsibility of the Bureau of Building Construction.

In thirteen of the 15 agencies only a minor change of responsibility was required to implement the solar financial incentive program. A major change was required in one of the two remaining agencies, and the second agency was entirely new. Conflict between

Table 3. FACTORS EXPECTED TO INFLUENCE IMPLEMENTATION SUCCESS OF BOTH FINANCIAL AND RD&D PROGRAMS

Factor	Source
Amount of organizational change required to implement incentive.	(Van Meter and Van Horn 1975)
Amount of conflict between executive and legislative branches in the state in all policy areas.	
Amount of conflict between executive and legislative branches in the state on solar energy related issues.	
Extent of involvement of implementing agency officials in formulating the legislative basis for the solar incentive.	(Elmore 1978; Van Meter and Van Horn 1975)
Existence of formal advisory arrangements between implementing agency and external groups such as solar interest groups, industry and trade associations, and universities.	(Ashworth et al 1979; Van Meter and Van Horn 1975)
Professional backgrounds of implementing agency staff.	(Ashworth et al. 1979)
Degree of enthusiasm for solar energy among implementing agency staff.	(Ashworth et al. 1979)
Number of registered/solar lobbyists in the state.	
Amount of informal interaction between implementing agency and external groups.	(Ashworth et al. 1979; Van Meter and Van Horn 1975)
Amount of influence on implementing agency activities by external groups.	(Ashworth et al. 1979; Van Meter and Van Horn 1975)
Public hearings have been held on implementing agency plans, especially rules and regulations.	

the executive and legislative branches on solar energy was minimal in 8 of the 11 study states and high in 1 state. Some conflict was acknowledged in the remaining two states. The patterns in the amounts of conflict suggest that solar energy was not an issue that created unusual political controversy. Only 6 of the 15 implementing agencies had had funds appropriated for implementing financial incentives; 5 of the 6 had designated or hired staff to implement incentive programs. Of the five agencies with designated or hired staff in 1977 and 1978, only two had at least one full-time equivalent (FTE) person, two others had less than one FTE, and one had none. In the remaining ten agencies, the incentive program was being implemented with less than one FTE in two agencies and with none formally designated in six others. (Two agencies did not provide information about staffing).

The dollar value of claims made in 1977 under solar income tax programs, excluding administrative costs, ranged from $0 to $11 million for the eight agencies reporting data (See Table 4). The median cost was $46,200. Seven of the eight reported 1977 administrative costs ranging from $0 to $46,200, with a median of $7500. For 1978, only four agencies reported both claims data and administrative costs. Only very scattered data on program costs were available for financial incentives other than income tax credits. The level of activity in these other programs was low, and state officials showed little interest in obtaining data on the costs or number of claims made. It was evident that these costs probably are quite low, reflecting the low level of program activity observed.

Eleven of fifteen agencies reported data on the number of valid claims processed in 1977. Only six of the eleven agencies reported both an aggregate number of claim applications and the number of valid claims. Table 4 presents information on claims processed for tax year 1977, dollar value of claims, and other available data for the six states. The numbers of valid claims ranged from 0 to 16,000 with a median of 173. The very large amount of California's dollar claims and the number of claims made for the tax year 1977 are largely due to claims for pool covers, which were included in that state's definition of eligible solar systems. According to data developed by the California Energy Commission (Rains 1979), more than 70% of the claims made for 1977 were for pool covers. When 1978 data for both the number of aggregate claims applications and the number of valid claims processed become available, there will be a more valid basis for comparative assessments of the consequences of different amounts of tax credits and definitions of eligible systems.

EFFECTS OF STATE BACKGROUND CONDITIONS ON IMPLEMENTATION OF FINANCIAL INCENTIVE PROGRAMS

Successful implementation of state solar incentives, undoubtedly, depends on the socioeconomics, politics, and climate of the individual states studied. We expected that a state's energy supply characteristics—the diversity of its energy production sources, its indigenous fossil fuel reserves, the cost of electricity, natural gas, and heating oil, and the amount of solar radiation available—would affect the likelihood that significant solar and renewable energy incentive programs would be proposed and successfully implemented. In addition, a state's energy demand as indicated by average annual heating degree days, energy consumption per capita and per capita consumption growth rate, and population growth should influence the extent to which alternative energy programs would be initiated and successfully implemented. Finally, a state's political and demographic setting are likely to influence its interest in solar and alternative energy programs. For example, states with a history of innovative activity, low levels of interparty competition, relatively high levels of fiscal resources, and relatively high levels of economic growth should be more likely that other states to initiate and implement financial incen-

Table 4. DATA ON STATES IMPLEMENTING SOLAR INCOME TAX CREDIT LEGISLATION IN 1977 TAX YEAR

State	Size of Tax Credit[a]	Dollar Amount of Claims, 1977[a]	Number of Claims, 1977[a]	Estimated Solar Systems Installed During 1977[b]	Number of Solar Systems In Place, 1978[c]	State Per Capita Income, 1977	Number of Tax Returns 1977[d]
Arizona	35%	135,000	388	500	2,500	$5,199	NA
California	55%	11,400,000	16,000	9,000	35,000	$7,151	9,000,000
Hawaii	10%	230,000	1,101	1,600	6,500	$7,080	370,732
Montana	10%	5,000	75	100	400	$5,689	341,000
North Dakota	10%	6,300	76	13	70	$5,846	300,000
New Mexico	25%	93,749	173	500	2,100	$5,322	499,863

[a]Size of tax credit, number of claims, and dollar value of claims are not strictly comparable across states because of differences in definitions of eligible systems, maximum permissible amount of claims, and carry-over provisions.

[b]Extrapolation of data from Solar Energy Institute of North America, 1979.

[c]Solar Energy Institute of North America, 1979.

[d]NA means not available.

tives. States in which a relatively large proportion of revenues is derived from income and sales taxes would be more likely to develop tax-based financial incentives for solar systems.

We first correlated each of the variables that describes a state's background with each measure of implementation success. To maintain a conservative approach, we employed a nonparametric statistic, Spearman's Rho, to test for significance; the criterion for significance was 0.05 or less. We were also interested in how the background characteristics of the 18 states studied differed from those of the remaining states. A comparison of study and nonstudy states should suggest how states with relatively long-lived, significant solar programs differ from other states. Of the hundreds of possibly significant relationships between state background characteristics and measures of program implementation, only about 50 were statistically significant and included a sufficient number of cases to be meaningful.

Larger financial incentive programs, as measured by the number of staff and the number of valid claims processed during 1977, occur in states with relatively large per capita budget surpluses and oil reserves per capita, large and growing populations, and high levels of insolation. This level of activity is not driven by high energy costs or energy consumption within active states, however. Only a few of the dozens of possible relationships between state characteristics and implementation outcome proved significant, but no clear pattern appeared among those that were. The time it took for a state to develop formal rules and regulations determining eligibility for the financial incentive indicates the staff skills of the implementing agency and the degree of consensus and political support for the incentive. States with high levels of insolation appear to be states which have a well-staffed implementing agency and political backing for the incentive, but these are not states with high heating requirements.

Because study states in late 1978 generally exhibited more solar activity than nonstudy states, we expected (and subsequently found) that background conditions differentiating states with relatively successfully implemented solar programs would differentiate also between study and nonstudy states. Compared with 39 other states, the 11 states with significant solar financial incentives exhibited few of the expected relationships, and no clear patterns in these relationships emerged. One interesting finding was that study states were more likely than nonstudy states to be ranked as regional leaders and as more innovative than their neighbors in past studies of innovation among states. It is important to note that state solar financial incentive activity does not, in general, appear to be a consequence of economic, political, demographic, or climatic conditions.

EFFECT OF ORGANIZATIONAL AND ADMINISTRATIVE FACTORS ON IMPLEMENTATION OF STATE SOLAR FINANCIAL PROGRAMS

This section summarizes an analysis of relationships between the ways states organize and administer financial incentive programs for solar applications and the extent to which these programs have been successfully implemented. Because of the predominance of solar income tax credits among the 11 states studied, this form of financial incentive was emphasized in the analysis. In addition to the admininstrative and organizational factors expected to influence both financial and RD&D programs, several factors unique to financial incentive programs were identified as likely to influence successful implementation:

- Type of implementing agency: energy agency, tax authority, the joint responsibility of these two agencies, or another type of agency entirely;

- The degree of specificity of rules and regulations that govern eligibility for the incentive; and
- The amount of documentation required to verify a claim for a financial incentive.

The analysis combined statistical tests of significance between measures of organizational and administrative factors and measures of implementation success with qualitative analysis based on interviews and observations in the states studied.

State solar financial incentive legislation and successfully implemented solar financial incentive programs result from different forces acting on state policy makers and administrators. The passage of incentive legislation may be symbolic politically and significant for increased solar applications. Property tax exemptions or reductions were popular among the states studied because no state funds are required for their implementation; but there were no property assessors skilled in appraising solar applications to execute the law locally. In fact, most local building officials did not know there were state solar property tax laws. Sales and use taxes have minimal fiscal impact and, therefore, the taxes often are enacted for symbolic reasons. This incentive resulted in minimal efforts to implement it. Each of the three solar loan programs studied was unique, directed toward specialized audiences, and implemented under widely varying conditions. As a result, no generalizations about the conditions leading to successful implementation are possible now. Business solar tax credits are rare, and usually accompany and are overshadowed by individual solar income tax credit programs. Business credits are considered secondary in importance to individual tax credits, and only minimal effort has been devoted to their implementation.

Solar income tax credits directed toward individuals proved to be the most significant incentive in terms of implementation activity and fiscal impact. Choice of reimbursement mechanism and the complexity of the rules and regulations governing eligibility depended on a state's size and its historical pattern of use of fiscal instruments to achieve policy goals. Relatively large states with complex, bureaucratic structures tended to write highly complex, technically specific and sophisticated regulations; smaller states wrote regulations that were easier to administer.

The type of agency selected to implement solar tax credit legislation had profoundly influenced the expertise that was brought to bear on implementation, the specificity of the rules and regulatons written, and the level of staff resources allocated to implementation. If state energy agencies help to implement solar tax credit legislation (either as the only responsible party or jointly with the state tax authority), they tend to prepare technically specific rules that cover major contingencies such as system eligibility, certification, and warranty coverage. If other types of agencies, particularly tax authorities, have sole implementation responsibility, they draw up very general rules and regulations--or none at all. Generally, tax authorities do not regard implementing solar tax credits as part of their mission, lack the technical expertise in solar energy, allocate minimal staff to implementation, and provide little information to taxpayers about the existence and interpretation of the solar incentive.

Table 5 summarizes the findings of analyses of how organizational and administrative factors are related to measures of implementation success. Most states allocated very small staff resources to implementing solar financial incentives, but those agencies with relatively large staffs interacted extensively with, and were significantly influenced by, external groups such as industry and trade associations and solar interest groups. These

Table 5. SUMMARY OF FINDINGS FOR FINANCIAL PROGRAMS: RELATIONSHIP BETWEEN ORGANIZATIONAL AND ADMINISTRATIVE FACTORS AND MEASURES OF IMPLEMENTATION SUCCESS

Organizational and Administrative Factors	Implementation Outcome: Level of Effort	Normalized Level of Effort	Administrative Cost	Time from Enactment to Rules and Regulations	Ratio of Number of Claims Processed to Number of Solar Systems Installed During 1977	Ratio of Number of Valid Claims Processed to Total Number of Tax Returns Filed in 1977
Professional Background of Staff	NS[a]	NS	NS	NS	NS	NA[e]
Type of Implementing Agency	NS	NS	NS	X[d]	NS	NS
Amount of Organizational Change Required to Implement	NS	ID[c]	NS	NS	NS	ID
Level of Legislative/Executive Conflict in General	NS	NS	NS	NS	NS	NS
Level of Legislative/Executive Conflict Over Solar Issues	—[b]	NS	—	+	NS	NS
Involvement of Agency Officials in Legislative Formulation	+[b]	NS	+	NS	NS	ID
Staff Enthusiasm for Solar Energy	+	NS	+	—	NS	NS
Number of Registered Solar Lobbyists	NS	ID	+	—	ID	+
Extent of Informal Interaction of External Groups with Program Activities	+	NS	+	NS	ID	NS
Amount of Influence External Groups Have on Agency Activities	+	NS	+	NS	ID	NS
Public Hearings Held	+	NS	+	—	NS	NS
Specificity of Rules and Regulations	+	ID	+	—	NS	ID
Amount of Documentation Required to Verify a Claim	+	ID	+	NS	NS	ID

[a]NS means not significant.

[b]+ and - indicates direction of significant relationship.

[c]ID denotes insufficient data.

[d]X stands for significant relationship.

[e]NA means not available.

large staffs were heavily involved in the formulation of the incentive legislation, were favorably disposed toward solar energy, and enjoyed a political setting exhibiting little conflict between the executive and legislative branches over solar energy issues. In most cases, the characteristics of large staffs were present in states that chose an energy agency to implement the solar financial incentive. The most useful measure of implementation success—the time required for the implementing agency to prepare rules and regulations governing eligibility—revealed that highly specific rules and regulations (written when energy agencies were involved in implementation) were associated with shorter implementation periods. Registered solar lobbyists, possibly reflecting a favorable overall political climate in the state for solar energy development, appeared to speed the process of writing rules and regulations.

Preliminary observations can be made on the results of solar income tax credit claims made in six states for the 1977 tax year (See Table 6). The median adjusted gross income of solar claimants is high, reflecting both the high initial capital cost of solar systems and that the higher-income taxpayers are attracted to tax credits. Large differences in the size of tax credits in these six states had little influence on the percentage of increase in installed solar systems betwen 1977 and 1978, but differences in system definitions, the conditions under which the incentive was introduced in these states, and the uncertain quality of the data limit the conclusions we can draw.

Solar financial incentives are rarely part of an integrated state plan with consistent rules, definitions of eligible solar systems, and coordinated efforts among different implementing agencies. Multiple financial incentives in the same state, therefore, do not complement one another. Gubernatorial endorsement of incentives influenced their implementation, often revealing whether an incentive was largely symbolic or substantive. States varied greatly in their governor's stance toward solar energy incentives, and the election of a new governor often led to large changes in incentive legislation and partially implemented programs. On the other hand, legislatures rarely paid much attention to a financial incentive once the legislation was passed, especially to a solar financial incentive whose impact on the treasury of most states was small.

DESCRIPTION OF RD&D PROGRAMS IN SELECTED STATES

The total dollar value of grants and contracts awarded in 1977 for the 12 programs studied ranged from $30,000 to $3.9 million, with a mean value of about $700,000. In 1978, the range was from $16,000 to $6.4 million, with a mean of about $900,000. Large, wealthy states are not necessarily those states that allocate the most resources to solar and renewable energy RD&D on a per capita basis. Hawaii, Montana, New Mexico, and Arizona stand with New York as the states most generous in their funding of such programs (see Table 7).

State solar energy RD&D programs are funded through the appropriation of state general revenues, the sale of state revenue bonds, levying of a surcharge on energy sales, or "earmarked" funds received from a mineral severance tax. In several states a combination of these funding methods is being used. Among the states studied, seven RD&D programs were funded by annual appropriations, two through a mineral severance tax, and one each by an energy sales surcharge, a combination of annual appropriations and bond sales, and a combination of an energy sales surcharge and bond sales.

State-generated program funds can be used to lever federal, private, or other government RD&D funds on a matching or cost-sharing basis. Based on data from eight programs, RD&D performers contributed, on average, a dollar of their own funds for every

Table 6. DATA ON STATES IMPLEMENTING SOLAR INCOME TAX CREDIT LEGISLATION IN 1977 TAX YEAR

State	Size of Tax Credit[a]	Dollar Amount of Claims, 1977[a]	Number of Claims, 1977[a]	Estimated Solar Systems Installed During 1977[b]	Number of Solar Systems In Place, 1978[c]	Increase in Number of Solar Systems Installed, 1977-1978	Adjusted Median Gross Income of Claimant
Arizona	35%	135,000	388	500	2,500	25%	NA[d]
California	55%	11,400,000	16,000	9,000	35,000	35%	$29,876
Hawaii	10%	230,000	1,101	1,600	6,500	33%	$28,250
Montana	10%	5,000	75	100	400	33%	$23,906
North Dakota	10%	6,300	76	13	70	23%	NA
New Mexico	25%	93,749	173	500	2,100	31%	$19,608

[a]Size of tax credit, number of claims, and dollar value of claims are not strictly comparable across states because of differences in definitions of eligible systems, maximum permissible amount of claims, and carry-over provisions.

[b]Extrapolation of data from Solar Energy Institute of North America, 1979.

[c]Solar Energy Institute of North America, 1979.

[d]NA means not available.

Table 7. STATE SOLAR RD&D PROGRAMS: PER CAPITA EXPENDITURES

	Total Dollar Value of Grants and Contracts Awarded in 1977 (x1000)	State Population in 1977 (x1000)	Equivalent per Capita Expenditure for 1977	Total Dollar Value of Grants and Contracts Awarded in 1978 (x1000)	State Population in 1978 (x1000)	Equivalent per Capita Expenditure for 1978
Arizona	490	2,305	0.21	490	2,354	0.21
California	728	21,887	0.03	744	22,294	0.03
Colorado	30	2,625	0.01	0	2,670	0
Florida	1,236	8,466	0.14	555	8,594	0.06
Hawaii[a]	NA[c]	891	-	1,666	897	1.85
Maine	0	1,084	0	16	1,091	0.01
Montana[b]	937	766	1.22	287	785	0.36
New Mexico	388	1,196	0.32	235	1,212	0.19
North Carolina	—	5,515	—	128	5,577	0.02
New York	3,900	17,932	.22	6,400	17,748	0.36
Ohio	61	10,696	0.005	50	10,749	0.004
Texas	—	12,806	—	406	13,014	0.03

[a]Includes OTEC grant and contract funds.

[b]Montana's renewable energy grants program did not engage in a full funding cycle in 1978 owing to legislative review of the program and judicial review of the programs' funding source, a coal severance tax.

[c]NA indicates not available.

dollar of state funds for solar RD&D projects. State solar programs attracted, on average, two federal dollars for every state solar RD&D dollar. Among the programs studied, the ability to attract federal RD&D funds ranged from zero to eight-and-one-half times one state's program funds (Hawaii). Only two programs required some cost sharing with the RD&D performer. The Texas RD&D program attempts to limit its share of project funding to 33% for demonstrations, 50% for development projects, and up to 100% for research. The New York alternate energy program, with the largest budget of the state programs studied, averaged only 4% matching funds from RD&D project performers.

Program emphasis, as indicated by the proportion of funds devoted to research, development and demonstration, showed no general pattern over the 10 programs for which data were available. Though these programs overall allocated approximately equal resources to each type of activity, the variation among states was very large (see Table 8). This finding is inconsistent with our expectation that state RD&D programs would emphasize applied research and demonstrations. Though National Science Foundation definitions were used in our field work, respondents may have introduced a systematic bias toward research-oriented answers into the data. No attempt was made to validate the data by classifying state RD&D projects using project titles as a guide to their position along the spectrum from research to demonstration.

BACKGROUND CHARACTERISTICS AND THE IMPLEMENTATION OF RD&D PROGRAMS

Relatively high levels of solar RD&D program activity (both absolute and per capita) are found in relatively urbanized, growing, wealthy states that have had a history of high levels of spending for R&D programs. States with large programs face relatively high costs for electricity and tend to produce more of their electrical energy from oil than do other states in the study. Yet climatic conditions and levels of energy consumption cannot explain their interest in solar RD&D: these states also are relatively low per capita consumers of energy and have lower heating requirements than other study states. These states enjoy high levels of insolation.

The data available on administrative costs of RD&D programs are sufficiently sparse that quantitative analysis is probably inappropriate. (Data on administrative costs were available from only about half the programs studied). For those programs where data were available, administrative costs tended to be higher in states that could afford it: they had relatively larger government surpluses, higher per capita incomes, and lower electricity and natural gas prices.

Few clear patterns emerged among relationships between measures of implementation success and state background characteristics. In general, there were few significant relationships at all, though limitations in the number of cases for many variables render this a tentative conclusion. The remaining, significant relationships lack ready explanation. In the absence of theory to guide expectations, neither prediction nor explanation of the observed relationships is simple.

The 12 states studied with solar RD&D programs enjoy significantly more insolation than other states and, as expected, they spend more on energy R&D (total and per capita). They had significantly more solar installations at the end of 1978 than nonstudy states, but the existence and direction of a cause/effect relationship cannot be inferred from these data alone. RD&D study states also exhibited significantly more residential housing starts in 1977 and 1978 than other states, but other measures of growth rates (e.g.,

Table 8. RD&D PROGRAM EMPHASIS

State	Proportion of Program Funds Devoted to Research (%)	Proportion of Program Funds Devoted to Development (%)	Proportion of Program Funds Devoted to Demonstration (%)
Arizona	20	40	40
California	66	17	17
Colorado	100	0	0
Florida	50	50	0
Hawaii	0	50	50
Maine	0	0	100
Montana	36	21	43
New Mexico	50	30	20
North Carolina	NA[a]	NA	NA
New York	20	40	40
Ohio	NA	NA	NA
Texas	19	48	33
Total	36.1	29.6	34.3

[a]NA means not available.

population growth during these years and growth in energy consumption from 1960 to 1976) showed no significant relationship to solar activity. These results suggest that state solar RD&D activity is not, in general, a consequence of economic, political, demographic, or climatic conditions.

THE EFFECT OF ORGANIZATIONAL AND ADMINISTRATIVE FACTORS ON IMPLEMENTATION OF STATE SOLAR RD&D PROGRAMS

This section describes the results of an analysis of relationships between the organization and administration of solar RD&D programs by states and the extent to which those programs have been successfully implemented. Specific measures of organizational and administrative factors likely to affect implementation success include those listed in Table 3 as well as these factors unique to the implementation of solar RD&D programs:

- Type of implementing agency: does the implementing agency administer most state energy and natural resources RD&D, most state energy RD&D, or most state alternative energy RD&D; or is it a non-RD&D agency?
- Source of implementing agency funds: is the state's solar RD&D program funded through annual appropriations, a severance tax, an energy surcharge, or some combination of these?
- Location of information dissemination activities concerning results of RD&D projects: is dissemination accomplished by staff of the RD&D agency, by RD&D performers, or jointly by the two?

Table 9 summarizes the significant relationships described in the preceding subsections. It is apparent that three things influence successful implementation of state solar RD&D programs: the professional backgrounds of the implementing agency staff, the type of implementing agency, and the source of funds for the RD&D program. Programs staffed heavily with persons from science and engineering backgrounds tend to have larger budgets and staffs (both in absolute and per capita terms), but engineers and scientists appear to be less interested in, or capable of, performing market analyses as part of the project selection process, involving end users in project selection decisions, and attracting federal money on a cost-sharing basis. The largest RD&D programs were organizationally separate from larger departments of energy and natural resources, probably reflecting the legislature's decision that, in those states, solar and alternative energy RD&D warranted both a substantial budget and distinct organizational status. Programs within larger states with more highly differentiated bureaucratic structures were more likely to obtain federal RD&D funds, but they were less likely than programs housed in state energy RD&D agencies to move quickly to promulgate rules and regulations governing funding procedures and eligibility, and less likely to conduct market analyses for projects intended for commercialization. Finally, implementing agencies funded partially or wholly from severance taxes and energy surcharges were larger and enjoyed a relatively higher rate of budget growth between 1977 and 1978 than agencies funded through annual appropriations. However, the annual appropriations process appeared to foster more rapid development of rules and regulations and a higher degree of cost sharing with RD&D performers.

SUMMARY AND CONCLUSIONS

What happens between the time a law is passed and when the consequences of that law are observed greatly influences whether the legislators achieve their purpose. In the case of state laws intended to stimulate the application of solar energy systems, the type of agency charged with implementing solar incentive legislation, the source of funding

Table 9. SUMMARY OF FINDINGS FOR RD&D PROGRAMS: RELATIONSHIP BETWEEN ORGANIZATIONAL AND ADMINISTRATIVE FACTORS AND MEASURES OF IMPLEMENTATION SUCCESS

Organizational and Administration Factors	Implementation Success: Level of Effort	Normalized Level of Effort	Market Analysis Performed	End-User Involvement	Time from Enactment to Rules and Regulations	% Cost Sharing with Performer	% Cost Sharing with Federal Government	% Increase in Dollar Value of Grants and Contracts, 1977-78
Professional Backgrounds of Staff	X	X	X[c]	X	NS	NS	X	NS
Type of Implementing Agency	X	NS	X	NS	X	NS	X	NS
Source of Implementing Agency Funds	X	X	NS	NS	X	X	NS	X
Location of Information Dissemination Activities	NS[a]	NS	NS	NS	NS	NS	NS	X
Amount of Organizational Change Required to Implement	NS	NS	+	NS	NS	NS	NS	NS
Level of Legislative/Executive Conflict in General	NS	NS	NS	NS	NS	NS	NS	NS
Level of Legislative/Executive Conflict Over Solar Issues	NS	NS	NS	NS	NS	NS	NS	NS
Involvement of Agency Officials in Legislative Formulation	NS	NS	NS	NS	NS	NS	NS	NS
Staff Enthusiasm for Solar Energy	NS	NS	NS	NS	NS	NS	NS	NS
Number of Registered Solar Lobbyists	ID	ID	ID	ID	ID	ID	ID	ID
Extent of Involvement & External Groups in Program Activities (planning, proposal review, project selection)	NS	NS	NS	+	NS	+	NS	NS
Amount of Formal Program Planning	NS	NS	NS	NS	NS	NS	NS	NS
Percent of Funds for Research	+[d]	NS	+	NS	ID	ID	NS	ID
Percent of Funds for Development	+	NS	-	NS	ID	ID	NS	ID
Percent of Funds for Demonstration	-[d]	NS	-	NS	ID	ID	NS	ID
Specificity of Enabling Statute	-	NS	NS	NS	NS	NS	NS	NS

[a]NS means not significant.

[b]ID indicates insufficient data.

[c]X denotes significant relationships.

[d]+ and - indicates direction of significant relationship.

support, the type of staff hired, and the agency's administrative procedures significantly affect the extent to which legislative language was successfully embodied in viable incentive programs.

States that are among the first to develop active solar incentive programs are relatively urbanized, wealthy, and growing (especially as measured by the number of new residential housing starts). There was little evidence that energy costs, indigenous fossil fuel reserves, per capita energy consumption, or heating requirements influenced states to develop relatively active solar incentive programs. If any single state characteristic appears to account for both the high level of solar incentive activity in a state and for the relatively successful implementation of its solar incentive program, it is the amount of sun that shines on that state. In other words, active solar states, those among the first to develop viable solar incentive programs, appear to have been driven by opportunity (high insolation) rather than by need (high energy costs, heating requirements, and low indigenous fossil fuel reserves).

From the perspective of resources devoted to implementing solar financial incentives, solar income tax credits directed toward individual taxpayers dominate state interest. Business tax credits, loan programs, sales tax exemptions, and property tax exemptions are distinctly of secondary importance and rarely attract the attention—or the resources necessary to implement them—that income tax credits do. Involvement of a state's energy agency from the early stages of legislative formulation to the finishing touches on rules and regulations governing eligibility for an income tax credit positively affects implementation. Though it is difficult to untangle causal relationships, it is clear that states making this choice enjoy the benefits of larger, more enthusiastic and technically qualified staff who more quickly write sophisticated rules and regulations than states selecting other types of agencies to implement this kind of incentive.

Data on solar income tax credits are available for only 1977, so that few conclusions about the efficacy of this incentive can be drawn. It is clear, however, that tax credits attract a relatively affluent segment of the population. With the exception of California, the cost of tax credits to the state treasury is modest. Very preliminary data reveal few differences among states in the proportional increase in number of solar systems installed, despite income tax credits ranging from 10 to 55%.

Several smaller states have made relatively large commitments to solar and renewable energy RD&D programs; Hawaii and Montana spend more on solar and renewable energy on a per capita basis than other states. It is surprising that state solar and renewable energy RD&D programs allocate resources almost equally among research, development, and demonstration because the commonly accepted view is that states tend to emphasize commercialization of solar technologies. The source of funding was important to the size and growth of these programs: the more stable and larger pool offered by severance taxes and energy-use surcharges usually meant relatively large program expenditures and higher growth rates. According to the measures of success, staffing solar RD&D programs with persons from science and engineering programs appeared to reduce the likelihood that the program would be implemented successfully.

These findings offer states some systematic information that can assist them in writing new solar incentive legislation, amending existing law, or improving the operation of existing incentive programs. Only additional research that documents the results of several more years of operation of these incentive programs will yield conclusions about the cost effectiveness of tax credits and other types of incentives in stimulating solar applications.

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